Ganging in Si tracker

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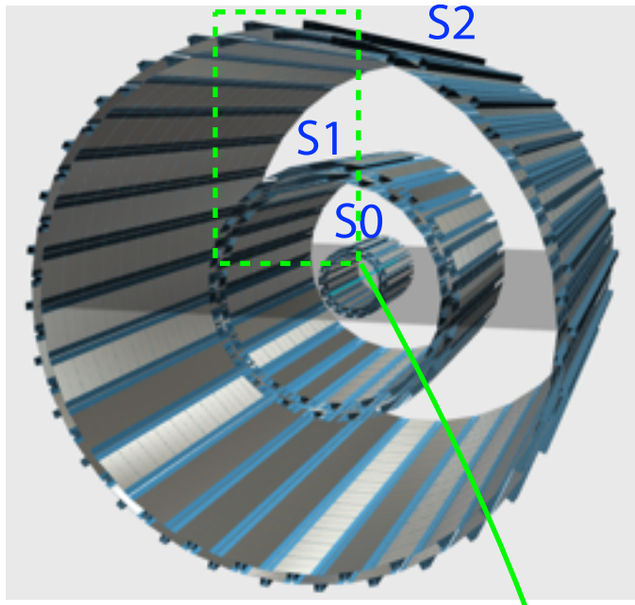
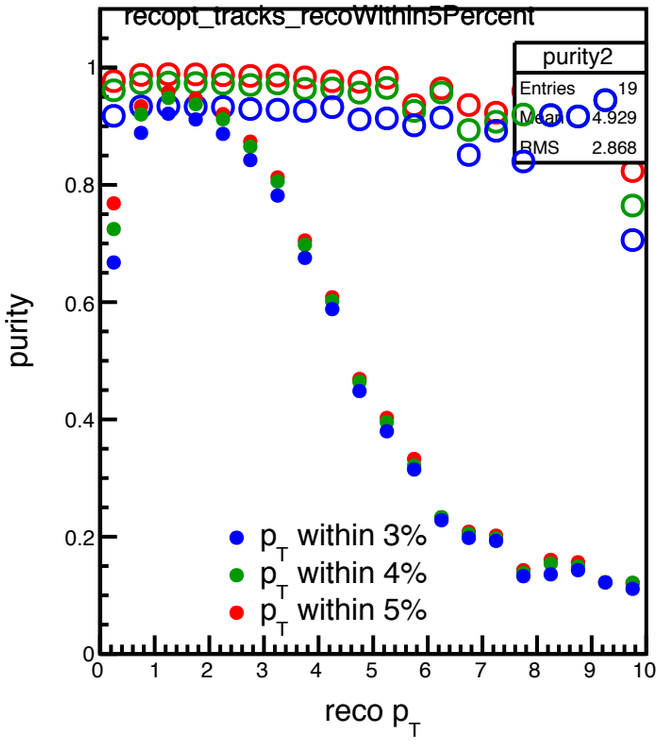
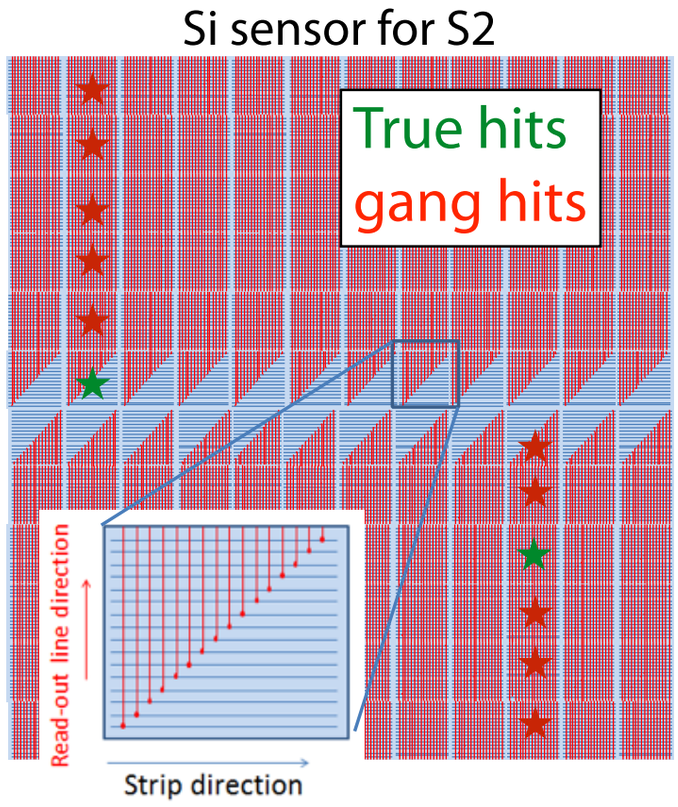
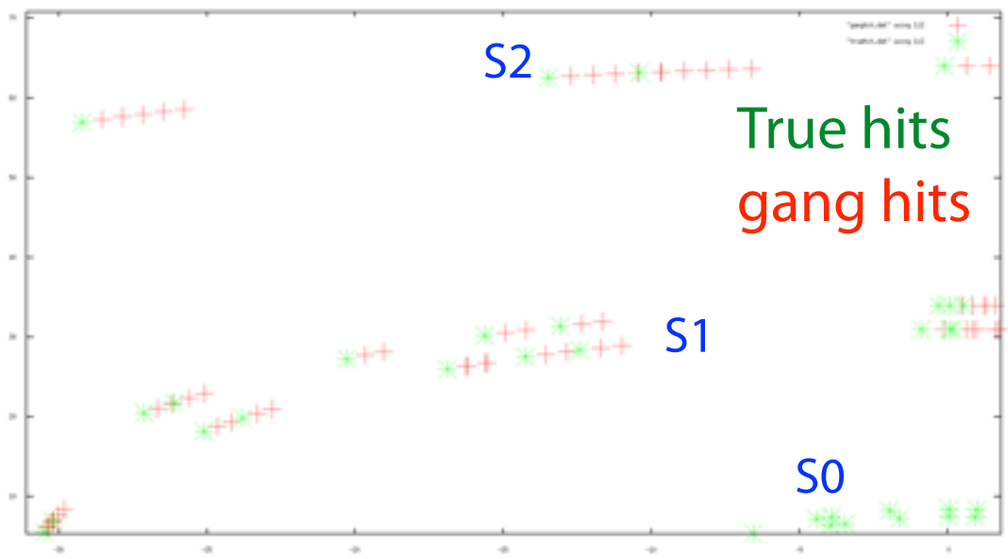
Introduction



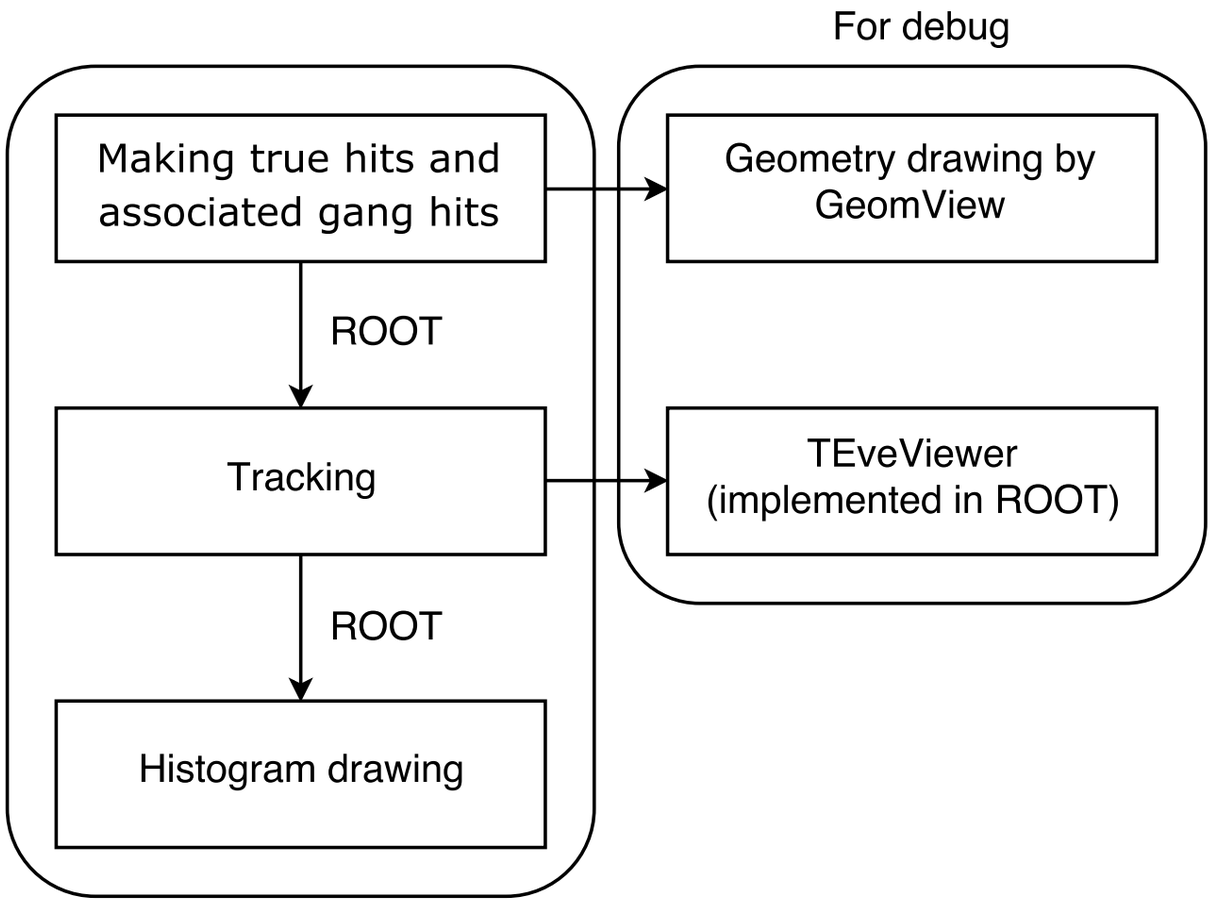
- A given hit on silicon sensor at S1 and S2 is inevitably accompanied by two or five 'gang' hits, respectively (right and middle figures).
- Gang hits may cause ghost tracks among 'final' tracks, leading to worse track purity and momentum resolution (left figure).
- I developed a toy MC simulation framework in order to understand how a track fit suffer from ganging and how to reduce ghost tracks, more simply than using full G4 simulations. So this framework aims a back-of-the-envelop calculation.







Simulation methodology



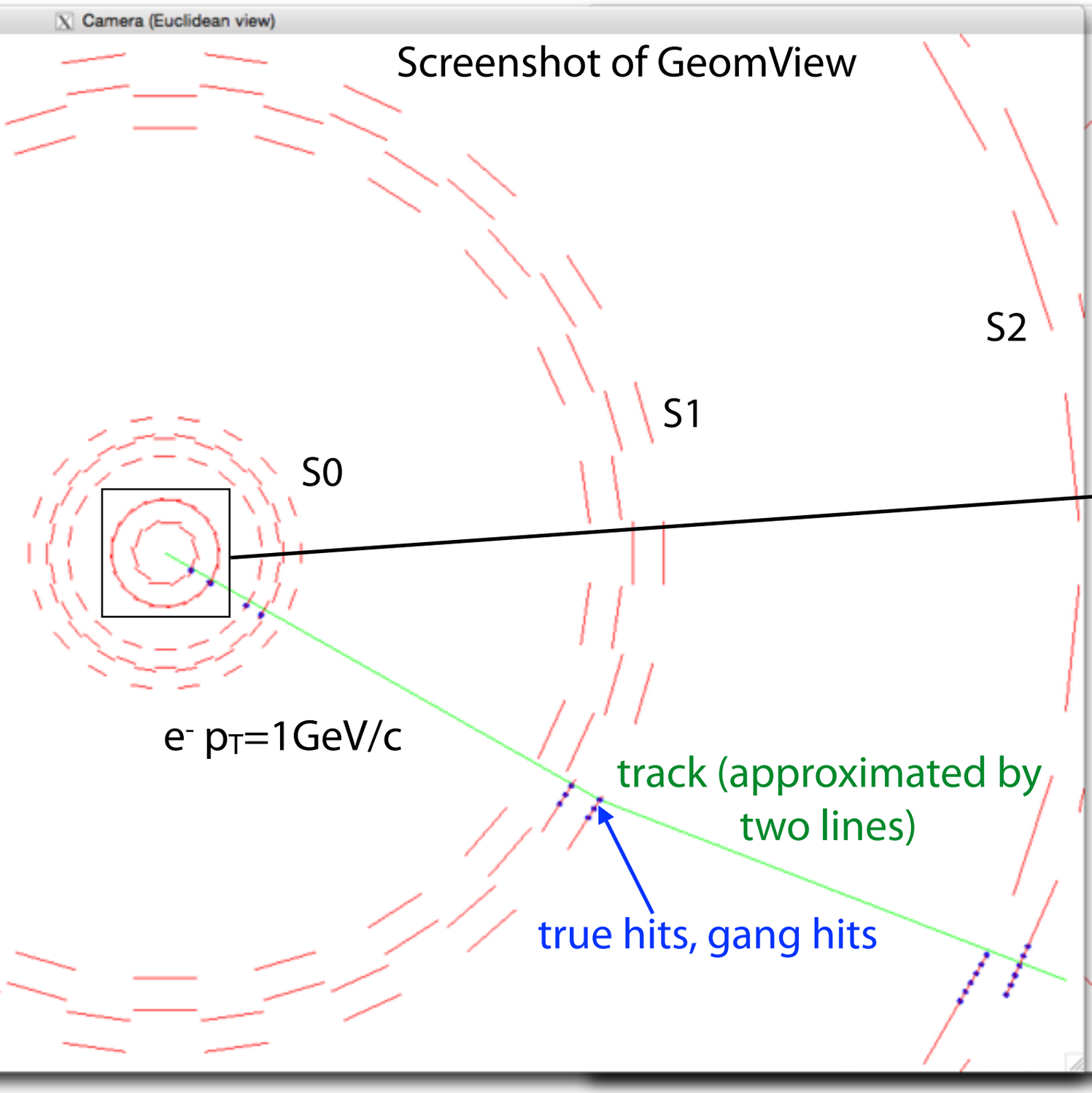
1. The Si tracker geometry is made by CGAL [1].
2. A true track with a given p_T is extended from (0,0) to outside the Si tracker.
3. True hit position are obtained by intersections between the track and the tracker.
4. Accompanied gang hits are made according to the true hit positions at the Si sensor.
5. Debug using a drawing by Geomview [2].

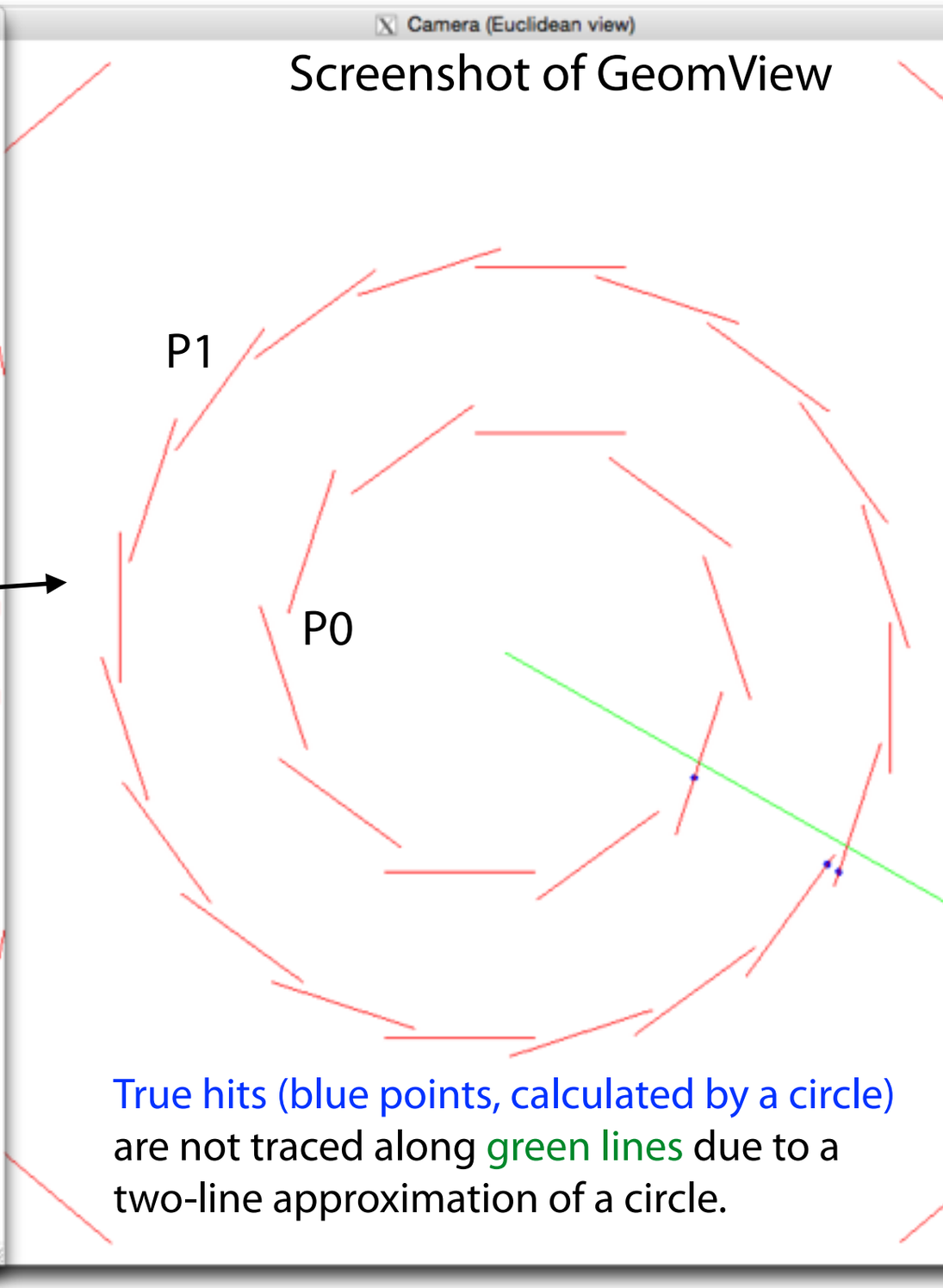
5. Track fitting to the true and gang hits is done by GENFIT [3]. A Kalman filter is used here.
6. Variance must be manually set before track fitting.
7. Track is roughly divided in two categories;
   (1) Track consists of only true hits
   (2) track includes at least one gang hit.
8. Debug using a TEveViewer (implemented in ROOT).

9. Histogram drawing by ROOT.

[1] CGAL (http://www.cgal.org/)
[2] Geomview (http://www.geomview.org/)
[3] GENFIT (http://genfit.sourceforge.net/Main.html)

Making true hits accompanied by gang hits





Note that a track is approximately drawn as two connected lines, since GeomView does not support a curved line or surface. Track is surely treated as a circle in the simulation.

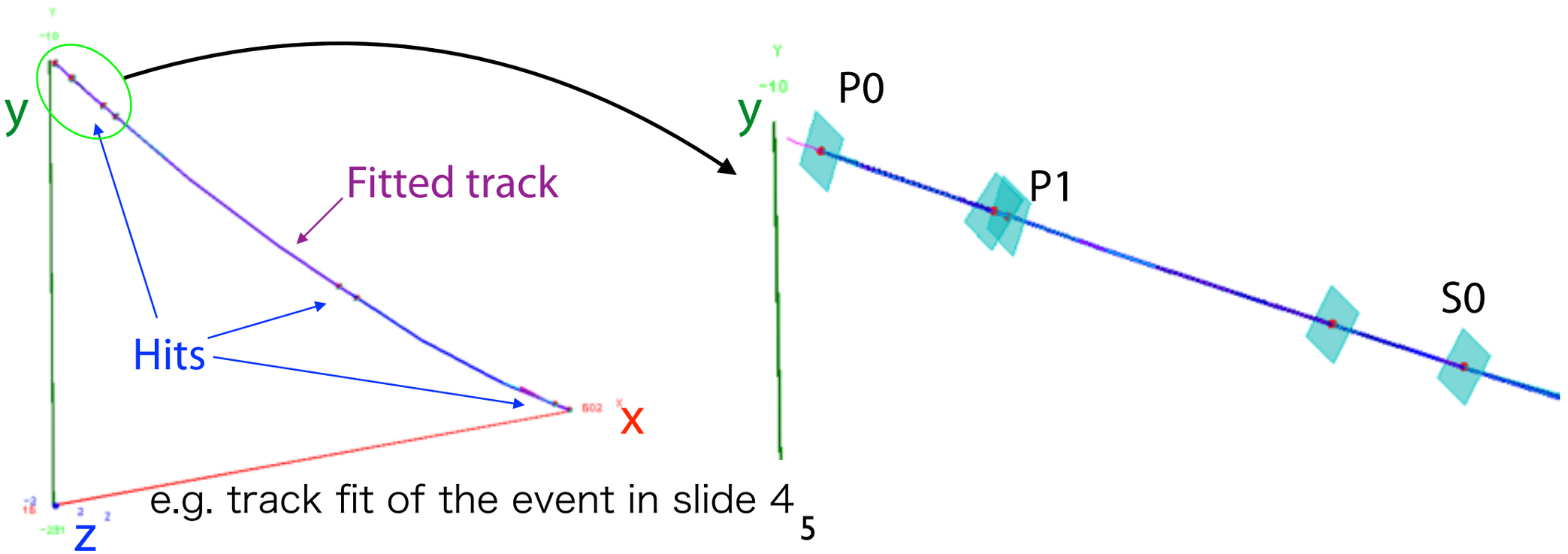
Track fitting

- Track fitting to the true hits and accompanied gang hits is performed by using a general-purpose track reconstruction 'GENFIT'.

- Track is divided into two types;
  (1) only true hits are used
  (2) at least one gang hit is used.

- In this study I assume one track per one event, so migration of neighbor hits into the track is not considered.

- Variance of each hit is not yet cared well. Need to tune it according to the strip width and clustering performance.

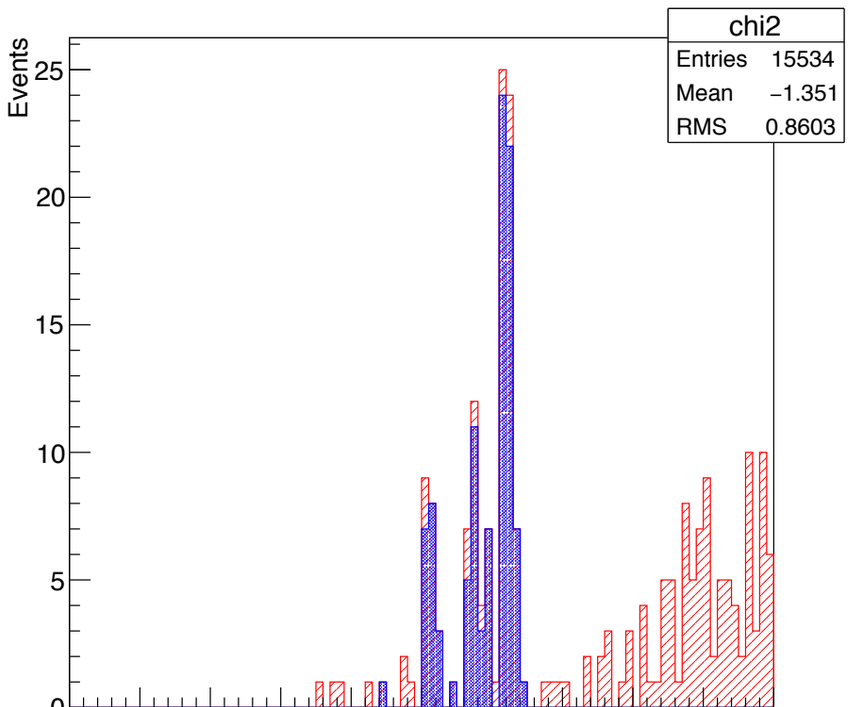


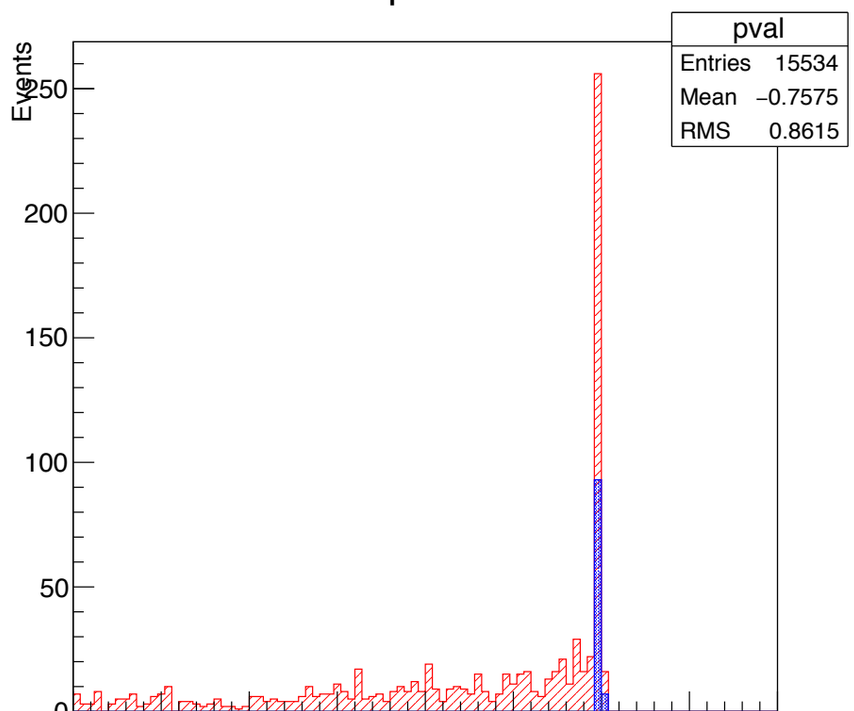
Results

Blue: track including true hits only

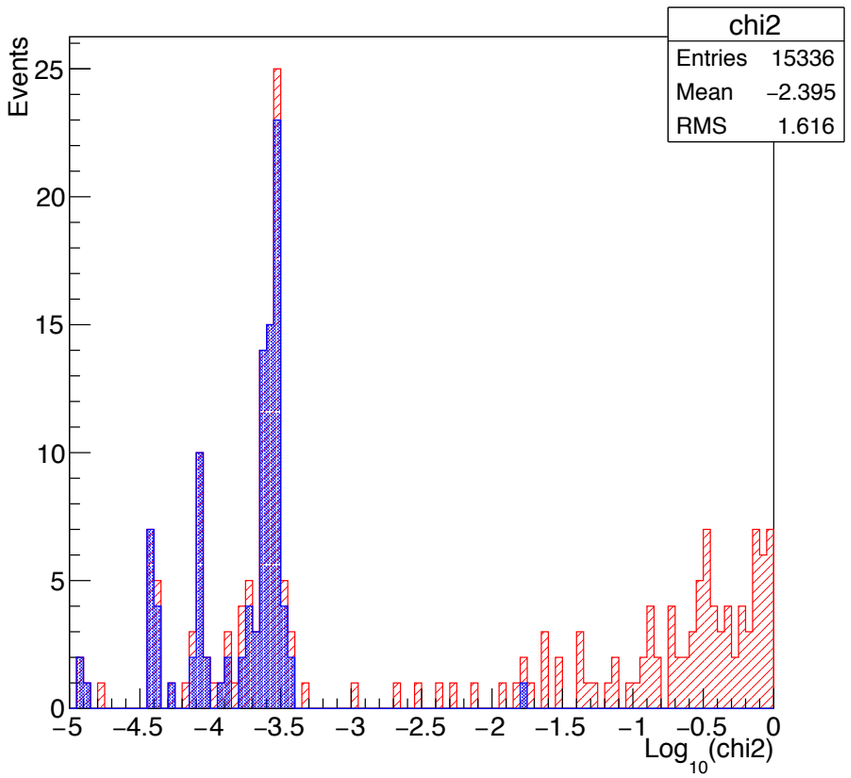
Red: track including at least one gang hit alternative to a true hit

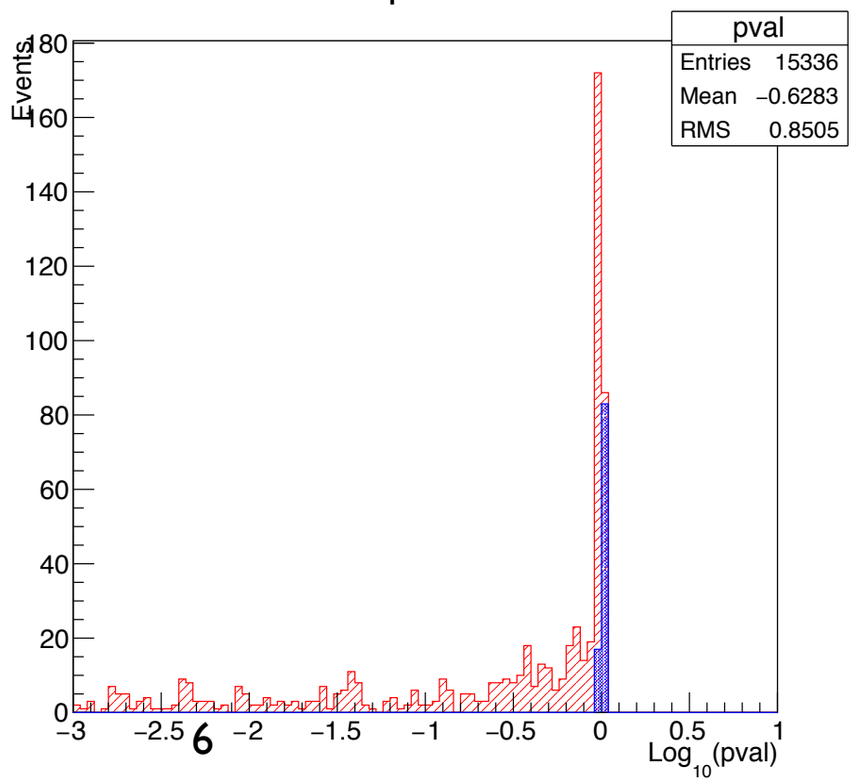
chi2 e^-, $p_T = 1$ GeV/c, 100events pval





chi2 e^-, $p_T = 10$ GeV/c, 100events pval





Summary and prospects

- I made a toy MC simulation framework, attempting to see how track fitting is done with gang hits and finally to develop ghost rejection algorithm and optimize the tracker design.
- Toy MC simulation works well.
- Chi2 for a track that includes at least one gang hit is significantly worth than that for the tracks with only true hits.
- Todo lists
  - need to tune the variance of true and gang hits (strip width, clustering performance, etc.)
  - optimize the tracker design according to the track fitting performance.
  - interesting to make a cylinder tracker and compare it with the current plane geometry.

Backup

No gang vs. with gang